

This document contains
6 pages.

AL-48-700506- 4
Copy 4 of
20 Copies

PAR 251

Image Enhancement Studies
Using Ring Smear
Techniques

1 October 1968

*Proposed PAR turned down - (Correspondence
in PAR 251 File) - Reinitiated + Funded
June 1969.*

Declass Review by NGA.

PAR 251

1 Oct 1968

SUBJECT: Image Enhancement Studies Using Ring Smear Techniques

TASK/PROBLEM

1. Design, fabricate, and mount a ring smear device on the BPE breadboard enlarger, and using this equipment:

- a. Develop equipment necessary to hold enlarged product and ring smear mask in registration during subsequent printing.
- b. Perform image enhancement on selected mission originals.
- c. Train selected contractor and customer exploitation personnel in ring smear image enhancement techniques.
- d. Study operating parameters of ring smear technique with the goal of improving the method.

PROPOSAL

2. Introduction:

a. This contractor has, in the recent past, employed a ring smear image enhancement process in an effort to give the intelligence community informational readout of photography which was not readily accessible through standard exploitation efforts. The results of this early work demonstrate the feasibility of this method both from a practical handling viewpoint as well as a practical exploitation aid. The results of these preliminary experiments have been demonstrated to 25X

b. In accordance with discussions between 25X
on 14 August 1968, it was decided that further work should be proposed in this area.

c. The ability to improve or enhance the intelligence value of reconnaissance photographs should be of significant value to the exploitation community. The ring smear technique has demonstrated merit in enhancing the

PAR 251

1 Oct 1968

readability and detectability of original negatives. Proposed herein is a procedure for study of the feasibility, practicality and effectivity of this enhancement on mission material. It is proposed that after the modification of existing breadboard equipment is completed and tested, the contractor will produce a number of ring smear enhanced enlargements of mission originals at the option of the customer.

3. Background. The theoretical and experimental considerations for the ring smear method of image enhancement can be found in References 11 and 12. Presented here is a brief summary of these reports.

a. Ring smear is a special case of unsharp masking in which a mask having a selected modulation transfer function is used to produce image detail enhancement over a controlled frequency bandwidth. In this technique, as opposed to other methods of unsharp masking, the gain of the system within the bandwidth may exceed 1.0. The special modulation transfer function of the ring smear mask includes phase inversion. This phase inversion is used to produce the high gain at the selected frequencies.

b. The ring smear mask is generated by imaging each point of the original as a circle. The diameter of the circle and the contrast of the mask affect the frequency and the amount of enhancement respectively in the overall system. The MTF of the mask can go to -0.40, which would yield a system response of 140% at that frequency. The system MTF in simplified terms can be written as

$$T_s = 1 - \gamma_m T_m$$

where T_s = MTF of the entire system

γ_m = gamma of the ring smear mask processing

T_m = MTF of the ring smear mask

Enhancement takes place when T_m goes negative.

PAR 251

1 Oct 1968

c. The mask must be made in a precision enlarger to permit subsequent registration with the original or duplicate. Circular smearing of negative detail is accomplished by spinning a tilted glass plate in the diverging optical beam of the enlarger. The mask and original (or unsmeared duplicate) are registered and contact printed to make the enhanced print. All materials must be handled with good sensitometric control to achieve best results.

4. General Approach. It is proposed that the contractor will utilize Government owned lenses and the breadboard BPE residual in the contractor's inventory as the precision enlarger for this project. The contractor will then design, fabricate, and mount an angular-adjustable, rotating smear plate in alignment with the lens mount, and appropriate registration pins on the easel of this enlarger. Following checkout and testing of the modified enlarger, image enhancement will be practiced on selected mission originals. The utility of this method of image enhancement will be based on examination of these mission prints. Following favorable results from this phase of the project, additional contractor personnel will be trained in the use of this equipment. Concurrent with the checkout and use of the ring smear equipment, studies will be conducted in the following areas:

- a. Effect of mask contrast on enhancement
- b. Selection of angular setting of glass plate and thickness of glass plate.
- c. The system and mask MTF's generated in a. and b.
- d. Reversal vs negative-positive materials for the mask
- e. Possible ways to minimize grain and artifacts in the masked system.

PAR 251
1 Oct 1968

PROGRAM OBJECTIVES

5. Construct and mount a glass plate ring smear device for the BPE breadboard.
6. Fabricate necessary equipment for registration of mask with original or duplicate in printing operation.
7. Make image enhanced prints from mission originals using ring smear techniques (9 man-week effort).
8. Train additional contractor and customer personnel in use of this equipment and technique (1.5 man-week effort).
9. Study the operating parameters of the image enhancement system to achieve controlled performance.

SCHEDULE

10. A tentative schedule covering major phases of effort is shown in Figure 1. The time span indicated to complete the subject program is based on the actual start of work. Upon approval to proceed and/or start of work, the schedule will be reviewed and necessary changes reported as required.

REFERENCE

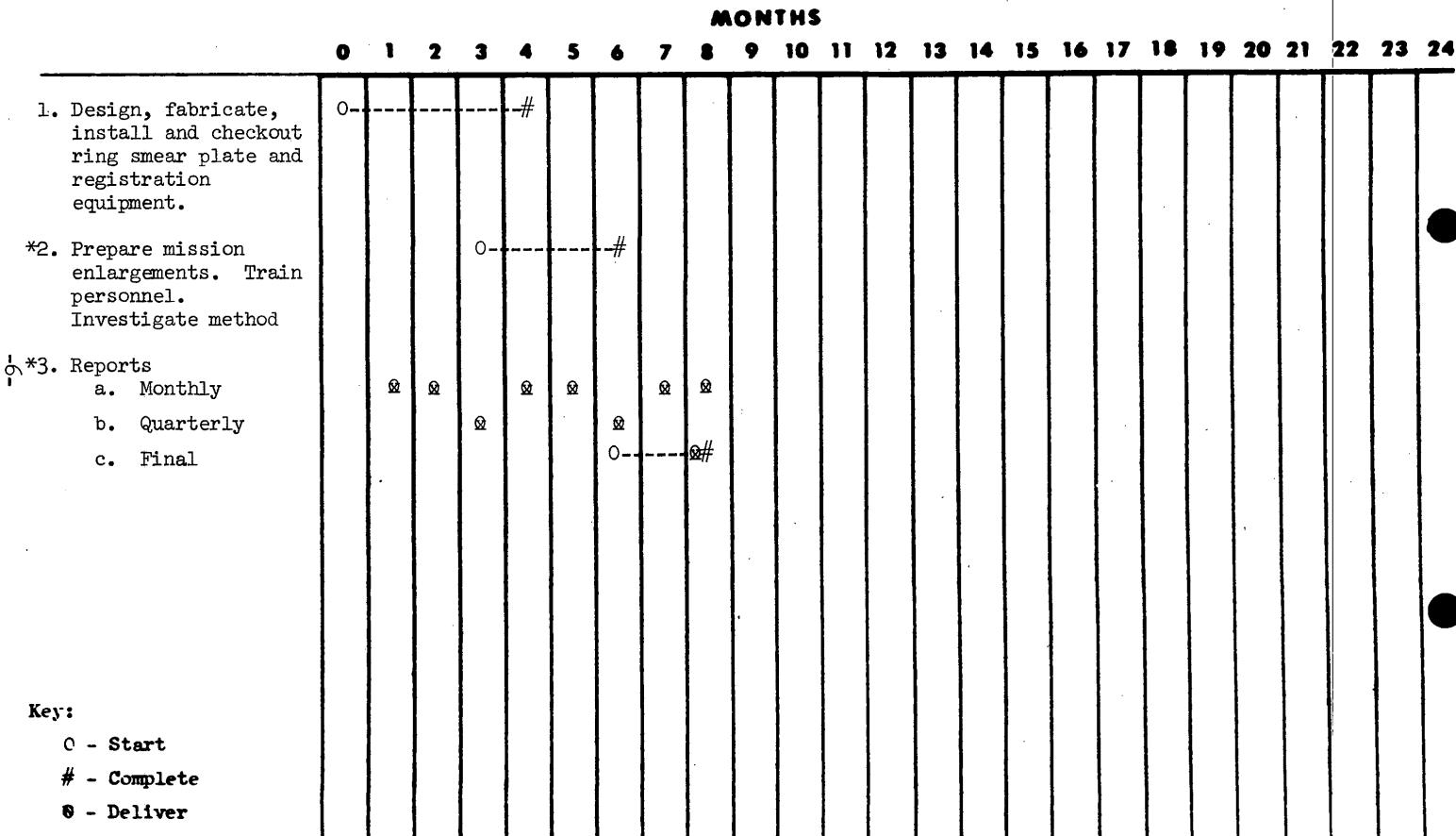
11. J. D. Armitage, A. W. Lohmann, and R. B. Herrick, "Absolute Contrast Enhancement", Appl. Opt., 4, 445-451, April 1965.
12. Bimonthly Progress Report No. 3, Contract NAS 9-7625, 31 May 1968, for NASA Manned Spacecraft Center, prepared by Eastman Kodak Company, Rochester, N. Y.

TENTATIVE SCHEDULE

PAR 251

Image Enhancement Studies Using Ring Smear Techniques

1 October 1968



Key:

- O - Start
- # - Complete
- ⊗ - Deliver

*The schedule for items 2 and 3 are based on the assumption that Lens Barrel Assemblies will be available.